Computer Corporation of America

79 02 07 023

575 Technology Square
Cambridge
Massachusetts 02139
617-491-3670

LEVEL II

(6) SIP ACCOMMODATION OF ADDITIONAL SEISMIC DATA SITES.

(12)

AD A064988

DDC FILE COPY

(10) Donald E. Eastlake, III

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(9) Technical Report CCA-79-08

(11) 29 January 1979

(12) 19 p.

DDC RECEIVED FEB 28 1979 A

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(15) This research was supported by the Advanced Research Projects Agency of the Department of Defense under Contract No. N0039-78-C-0246, ARPA Order No. 3540. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the Advanced Research Projects Agency or the U.S. Government.

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1. The SIP

The SIP is a dedicated minicomputer communications system developed and operated by Computer Corporation of America. It interfaces a real time seismic information network to the Datacomputer [DORIN and EASTLAKE].

The Datacomputer is a network data utility designed to support very large databases and shared access by remote heterogeneous computers [MARILL & STERN]. It is the only operational general purpose database system capable of handling datasets in excess of a trilliom bits [CCA].

Below, after a general description of the SIP, we describe its development history through the end of 1977 and the changes in the SIP and the seismic data flow in 1978.

2. General Description

The Seismic Input Processor (SIP) acts as a link between the world wide Vela Seismological Network (Velanet) and the Datacomputer. (See Figure 1.)

A primary function of the Velanet is the collection of real time seismic data from arrays of seismometers. This data is sent over leased lines and the Arpanet to the Communications and Control Processor (CCP) at the Seismic Data Analysis Center (SDAC) in Alexandria, Virginia. From the CCP this data is immediately distributed to various processors and to the Datacomputer, via the SIP, for storage as shown in Figure 2. This figure also shows the SDAC and Lincoln Laboratories UNIX systems which are presently the primary systems used by researchers retrieving seismic data from the Datacomputer.

The Datacomputer stores this data in its Ampex TBM mass storage system which is based on video tape technology [EASTLAKE]. This system has an approximately 200 billion bit on-line capacity consisting of four TBM tapes. Data accumulation in excess of this on-line capacity is stored on TBM tapes that are off line.

Figure 2.1

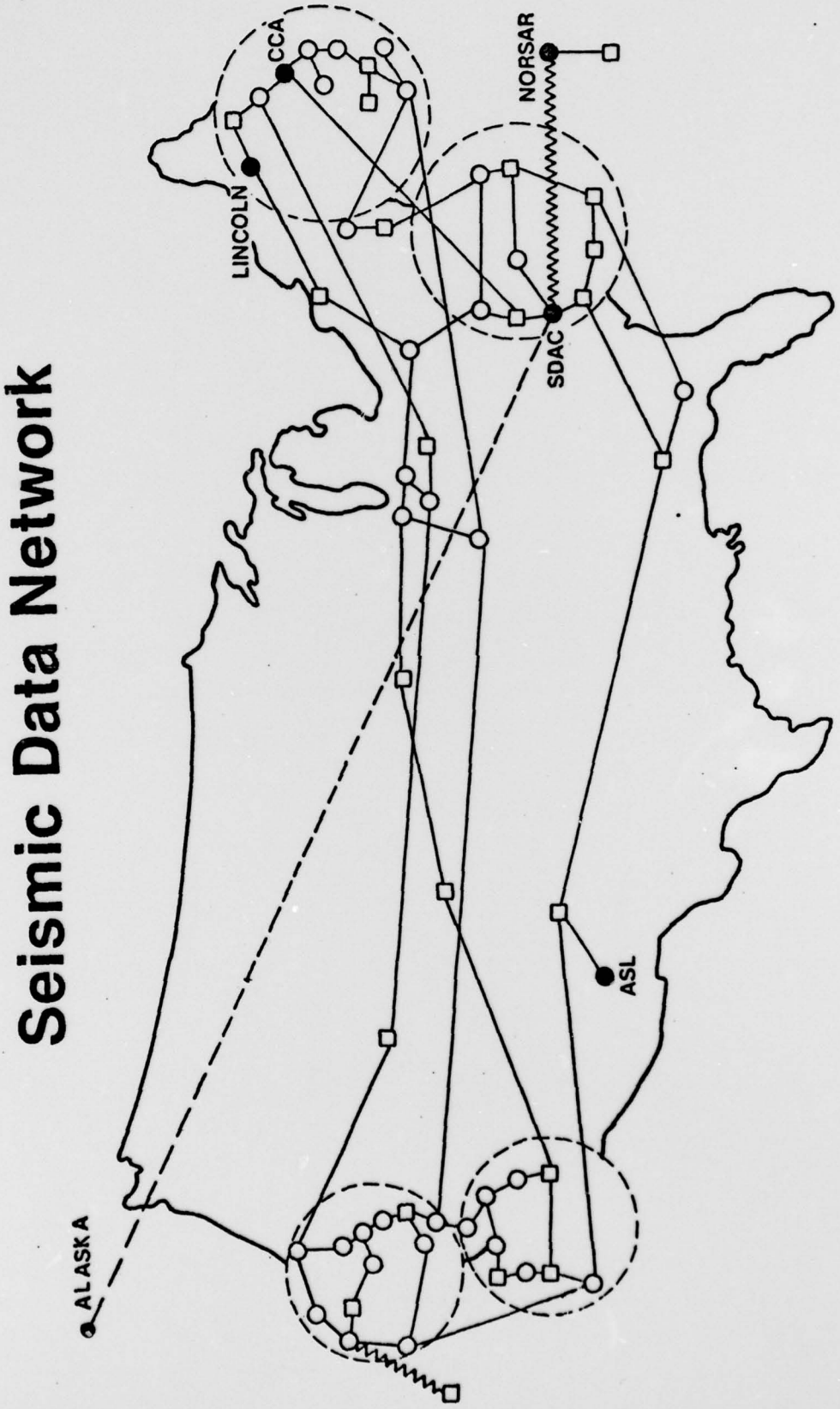
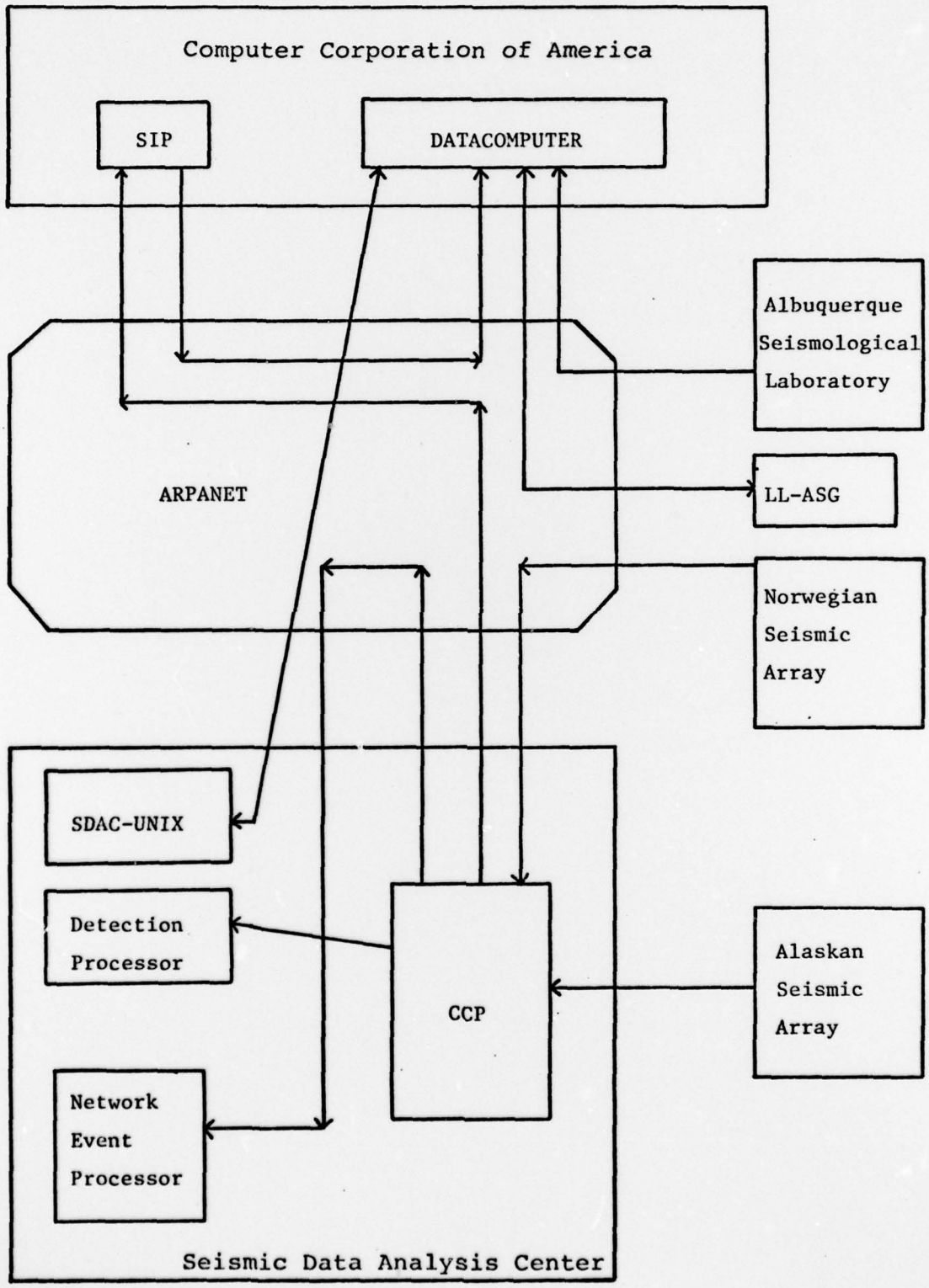
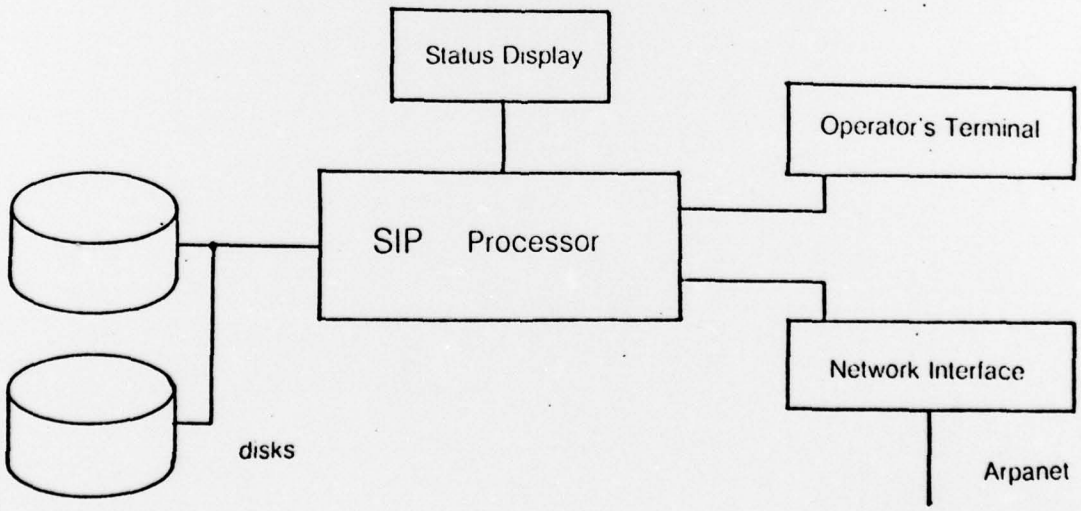


Figure 2.2


Computer Corporation of America
SIP
DATACOMPUTER
Albuquerque Seismological Laboratory
ARPANET
LL-ASG
Norwegian Seismic Array
SDAC-UNIX
Detection Processor
CCP
Alaskan Seismic Array
Network Event Processor
Seismic Data Analysis Center

The components of the Velanet that handle real time seismic array data, except for the Datacomputer, are dedicated systems designed to receive data in real time. The Datacomputer, however, operates within a non-real-time operating system and serves the general Arpanet community as well as the Velanet. Furthermore, it is occasionally unavailable due to scheduled and unscheduled maintenance work. To isolate the Datacomputer from these real time requirements, the SIP was implemented to receive real time data from the CCP, buffer and reformat this data on disk, and periodically forward the data to the Datacomputer.

Figure 2.3



The SIP's hardware structure is shown in Figure 3. It is implemented on a DEC PDP-11/40 computer. The SIP has an Arpanet interface, two RP-04 disk drives for buffering data, an operator's terminal, and a status display screen. With the present bandwidth and disk structuring, about two days of data can be held by the SIP.

Besides processing seimsic data, the SIP software provides for operator communications between itself and the CCP. It also send messages to the CCP for each chunk of data when the data has been properly filed in the Datacomputer.

3. Development History

SIP related work that occurred from 1974 through 1976 was funded under contract MDA903-74-C-0227, "Datacomputer Support of Seismic Data Activity". Work in 1977 was funded under contract MDA903-77-C-0156, "Datacomputer and SIP Operations". Work in 1978 was funded by the contract for which this report is being submitted.

The hardware configuration of the SIP was specified around the middle of 1974 at the time that the site modification at CCA to accommodate the SIP and the mass storage system were specified and the Ampex TBM mass storage system was ordered.

The SIP hardware was delivered in early 1975 and the SIP was connected to the Arpanet in June of 1975. The volume of seismic data to pass through the SIP and problems encountered in early tests indicated the necessity to upgrade the local Arpanet node at CCA. This was done in late 1975 when a model 316 TIP node was replaced with a model 516 IMP.

The SIP was fully operational and hundreds of hours of seismic data had been retransmitted to small test files in the Datacomputer by mid-1976. Further work was done in 1976 on improving the SIP's robustness in the face of hardware and communications troubles. Continuing problems with CCP<->SIP communications lead to the design of a new communications protocol to be used on this link. Meanwhile, the TBM mass memory was accepted and integrated with the Datacomputer and on October 1, 1976, the SIP-Datacomputer system became fully operational storing data into the mass storage system.

In the early parts of 1977, the new CCP<->SIP protocol [BBN] was implemented and the CCA local Arpanet node was further upgraded to a PLURIBUS IMP. These steps cleared up the previously chronic communications problems.

Since then, the SIP has been in virtually continuous operation, successfully receiving, buffering, reformating, and forwarding seismic data.

4. Modification to Accommodate Seismic Data Sites

As set up at the end of 1977, the SIP received data from three seismic arrays: LASA, the large aperture seismic array in Montana; NORSAR, the Norwegian array; and ALK, the Alaskan array. Each of these arrays provides both long period (one sample a second) and short period (ten or twenty samples a second) seismic data.

Since it was expected that the number of arrays would increase, the SIP's directory structure was modified. It has originally allowed for up to 4 sites. The modifications that were initially implemented provided for up to 8 sites and modification for higher numbers were investigated.

The data area on the SIP's disk is divided into "hour" slots. The disk is configured so that each of these slots has enough space for all the data received from the active sites. The SIP's disk directory has two status bits per site associated with each hour slot. These bits indicate whether there is data present from that site for that hour and whether the data has been stored in the Datacomputer. To allow more than four sites, it was necessary to change the indexing scheme used for accessing these bits.

In numerous locations, byte instructions [DEC] had been used on the assumption that 8 bits would be adequate for an expected four sites. It was necessary to change these byte operations to word operations and make additional adjustments due to other resulting directory layout changes. In the process, the code referencing these bits was gathered together to make futher modifications simpler.

However, the expected increase in the number of sites has not occurred. Instead, the present direction of development for the seismic system is towards the SWF or Seismic Waveform Files. These files are intended to include all the "interesting" Velanet data, primarily that associated with events or otherwise noteworthy. The availability of the SWF data makes continuous real time data of noticeably less importance.

The changes that have actually occurring during 1978 were a cessation of real time short period data, which required a very minor modification to the SIP, and later the termination of data from the LASA site when that site was permanently decommissioned.

We continue to receive and process real time long period data through the SIP and the SIP directory system modifications are still in place to enable us to easily

adapt to data from an increased number of seismic arrays when the need arises.

References

[BBN]
BBN Report No. 3460, "VELANET Communication Protocols between the CCP and the SIP and between the CCP and the DP", 5 April 1977.

[CCA]
Computer Corporation of America, Datacomputer Version 5 User Manual, Cambridge, Massachusetts, July 1978.

[DEC]
Digital Equipment Corporation, PDP11 04 / 05 / 10 / 35 / 40 / 45 Processor Handbook, 1975.

[DORIN and EASTLAKE]
R. H. Dorin and Donald E. Eastlake, III; "Use of the Datacomputer in the Vela Seismological Network"; Technical Report No. CCA-77-08, Computer Corporation of America, 575 Technology Square, Cambridge, Massachusetts, 02139, April 15, 1977.

[EASTLAKE]
Eastlake, III, D.E. "Tertiary Memory Access and Performance in the Datacomputer", Technical Report No. CCA-77-11, Computer Corporation of America, 575 Technology Square, Cambridge, Massachusetts, 02139, June 30, 1977.

[MARILL and STERN]
Marill, Thomas; and Stern, D.H. "The Datacomputer: A Network Utility", Proceedings AFIPS National Computer Conference, AFIPS Press, Vol. 44, 1975.

A. Sample SIP-Datacomputer Session, Early 1979

This session shows the transmission of two hours of data for two sites. Datalanguage generated by the Datacomputer is on lines starting with .I280 except for the "starting list output" lines. Lines beginning with "**" are continuations of the previous line.

```
;U000 790129055723  IONETI: ICP LISTENING
;0031 790129060259  IONETI: CONNECTED TO CCA-SIP-10
;J150 790129060300  FCRUN: V='DC-5/02.00.1' J=4 DT='MONDAY, JANUARY 29,
**1979 01:03:00-EST' S='CCA'
;J200 790129060300  RHRUN: READY FOR REQUEST
.I280 790129060302  LOGIN SDAC.SIP;
;0032 790129060303  ASPRIN: HOST='CCA-SIP' SOCK=8 REALMS=2925 CPUMS=410
**PGFLTS=35 PAGSEC=102 LOADED=1 INCORE=2214 LKTOT=4 DIRF=1 DINS=2 DIRD=5
** DIWR=2 NAFN=1 DLMSGWR=1 DLMSGRD=1 DLBYWR=192 DLBYRD=17
;0033 790129060303  ASLOG: USER='SDAC.SIP',Q=100
;J209 790129060303  RHRUN: EXECUTION COMPLETE
;J200 790129060303  RHRUN: READY FOR REQUEST
.I280 790129060305  OPEN %TOP.SDAC.VELANET.PROTOTYPES.CCA"-DUMMY;
;J209 790129060307  RHRUN: EXECUTION COMPLETE
;J200 790129060307  RHRUN: READY FOR REQUEST
.I280 790129060307  OPEN %TOP.SDAC.VELANET.ALPF.NAO.Y1979.M01;
;J209 790129060315  RHRUN: EXECUTION COMPLETE
;J200 790129060315  RHRUN: READY FOR REQUEST
.I280 790129060316  OPEN ALPF.NAO;
;J209 790129060321  RHRUN: EXECUTION COMPLETE
;J200 790129060321  RHRUN: READY FOR REQUEST
.I280 790129060322  CONNECT NAO 64;
;J209 790129060323  RHRUN: EXECUTION COMPLETE
;J200 790129060323  RHRUN: READY FOR REQUEST
.I280 790129060323  LIST M01 %INFO;
.I280 790129060323  COLP: STARTING LIST OUTPUT
.I281 790129060324  COLI: FINISHED WITH LIST OUTPUT
;J209 790129060324  RHRUN: EXECUTION COMPLETE
;J200 790129060324  RHRUN: READY FOR REQUEST
.I280 790129060324  MODE M01 APPEND;
;J209 790129060324  RHRUN: EXECUTION COMPLETE
;J200 790129060324  RHRUN: READY FOR REQUEST
.I280 790129060326  APPEND M01 , NAO SAMPLE = SAMPLE/*BITS=2073600  Cp
***/
.I280 790129060327  ;
;J205 790129060330  RHRUN: SUCCESSFUL COMPILATION
```

```
.I230 790129060330  OCPBO: OPENING INPUT SOCKET PORT= NAO
;I239 790129060332  OCPBO: OPENED INPUT PORT= NAO
;S359 790129060333  SXOP: SDAX OPEN = SDAC.VELANET.ALPF.NAO.Y1979.M01 79
**0129041526
.I250 790129060421  OCPBC: CLOSING INPUT SOCKET
;I259 790129060421  OCPBC: INPUT SOCKET CLOSED
;J209 790129060421  RHRUN: EXECUTION COMPLETE
;J200 790129060421  RHRUN: READY FOR REQUEST
.I280 790129060422  /*BPS=45078  */
.I280 790129060423  LIST M01 %INFO;
.I280 790129060425  COLP: STARTING LIST OUTPUT
.I281 790129060425  COLI: FINISHED WITH LIST OUTPUT
;J209 790129060425  RHRUN: EXECUTION COMPLETE
;J200 790129060425  RHRUN: READY FOR REQUEST
.I280 790129060426  APPEND M01 , NAO SAMPLE = SAMPLE/*BITS=1296576  Cq
***/
.I280 790129060427  ;
;J205 790129060433  RHRUN: SUCCESSFUL COMPILATION
.I230 790129060433  OCPBO: OPENING INPUT SOCKET PORT= NAO
;I239 790129060434  OCPBO: OPENED INPUT PORT= NAO
;S359 790129060435  SXOP: SDAX OPEN = SDAC.VELANET.ALPF.NAO.Y1979.M01 79
**0129060419
;S350 790129060437  SXAX2: SDA ALLOCATE = 2635. SDAC.VELANET.ALPF.NAO.Y1
**979.M01 3330#58#34800
;S350 790129060648  SXAX2: SDA ALLOCATE = 5. SDAC.VELANET.ALPF.NAO.Y1979
**.M01 3330#58#420
;S351 790129060650  SRMC8: SDA MERGE = 2640. SDAC.VELANET.ALPF.NAO.Y1979
**.M01 3330#58
.I250 790129060651  OCPBC: CLOSING INPUT SOCKET
;I259 790129060651  OCPBC: INPUT SOCKET CLOSED
;J209 790129060651  RHRUN: EXECUTION COMPLETE
;J200 790129060651  RHRUN: READY FOR REQUEST
.I280 790129060652  /*BPS=9897  */
.I280 790129060654  CLOSE NAO ;  CLOSE M01;
;J209 790129060655  RHRUN: EXECUTION COMPLETE
;J200 790129060655  RHRUN: READY FOR REQUEST
;J209 790129060655  RHRUN: EXECUTION COMPLETE
;J200 790129060655  RHRUN: READY FOR REQUEST
.I280 790129060656  OPEN %TOP.SDAC.VELANET.ALPF.ALK.Y1979.M01;
;J209 790129060701  RHRUN: EXECUTION COMPLETE
;J200 790129060701  RHRUN: READY FOR REQUEST
.I280 790129060702  OPEN ALPF.ALK;
;J209 790129060704  RHRUN: EXECUTION COMPLETE
;J200 790129060704  RHRUN: READY FOR REQUEST
.I280 790129060704  CONNECT ALK 64;
;J209 790129060705  RHRUN: EXECUTION COMPLETE
;J200 790129060705  RHRUN: READY FOR REQUEST
.I280 790129060706  LIST M01 %INFO;
.I280 790129060706  COLP: STARTING LIST OUTPUT
.I281 790129060706  COLI: FINISHED WITH LIST OUTPUT
```

```
;J209 790129060706  RHRUN: EXECUTION COMPLETE
;J200 790129060706  RHRUN: READY FOR REQUEST
.I280 790129060707  MODE M01 APPEND;
;J209 790129060707  RHRUN: EXECUTION COMPLETE
;J200 790129060707  RHRUN: READY FOR REQUEST
.I280 790129060708  APPEND M01 , ALK SAMPLE = SAMPLE/*BITS=806400  Cp *
**/
.I280 790129060709  ;
;J205 790129060715  RHRUN: SUCCESSFUL COMPILATION
.I230 790129060715  OCPBO: OPENING INPUT SOCKET PORT= ALK
;I239 790129060716  OCPBO: OPENED INPUT PORT= ALK
;S359 790129060718  SXOP: SDAX OPEN = SDAC.VELANET.ALPF.ALK.Y1979.M01
;S350 790129060722  SXAX2: SDA ALLOCATE = 1235. SDAC.VELANET.ALPF.ALK.Y1
**979.M01 3330#58#2745
!S311 790129060723  SXCX73: STAGING DATA FOR FILE = 1232. SDAC.VELANET.A
**LPF.ALK.Y1979.M01 TBM#21#183680
;S320 790129060828  SXCX8: STAGING COMPLETED FOR FILE = SDAC.VELANET.ALP
**F.ALK.Y1979.M01
;S350 790129060852  SXAX2: SDA ALLOCATE = 5. SDAC.VELANET.ALPF.ALK.Y1979
**.M01 3330#58#425
.I250 790129060854  OCPBC: CLOSING INPUT SOCKET
;I259 790129060854  OCPBC: INPUT SOCKET CLOSED
;J209 790129060854  RHRUN: EXECUTION COMPLETE
;J200 790129060855  RHRUN: READY FOR REQUEST
.I280 790129060856  /*BPS=8861  */
.I280 790129060857  LIST M01 %INFO;
.I280 790129060858  COLP: STARTING LIST OUTPUT
.I281 790129060858  COLI: FINISHED WITH LIST OUTPUT
;J209 790129060858  RHRUN: EXECUTION COMPLETE
;J200 790129060858  RHRUN: READY FOR REQUEST
.I280 790129060859  APPEND M01 , ALK SAMPLE = SAMPLE/*BITS=806400  Cq *
**/
.I280 790129060903  ;
;J205 790129060916  RHRUN: SUCCESSFUL COMPILATION
.I230 790129060916  OCPBO: OPENING INPUT SOCKET PORT= ALK
;I239 790129060917  OCPBO: OPENED INPUT PORT= ALK
;S359 790129060918  SXOP: SDAX OPEN = SDAC.VELANET.ALPF.ALK.Y1979.M01 79
**0129060852
;S350 790129060924  SXAX2: SDA ALLOCATE = 1235. SDAC.VELANET.ALPF.ALK.Y1
**979.M01 3330#58#3980
;S350 790129061027  SXAX2: SDA ALLOCATE = 5. SDAC.VELANET.ALPF.ALK.Y1979
**.M01 3330#58#530
;S351 790129061031  SRMC8: SDA MERGE = 1240. SDAC.VELANET.ALPF.ALK.Y1979
**.M01 3330#58
.I250 790129061032  OCPBC: CLOSING INPUT SOCKET
;I259 790129061032  OCPBC: INPUT SOCKET CLOSED
;J209 790129061032  RHRUN: EXECUTION COMPLETE
;J200 790129061033  RHRUN: READY FOR REQUEST
.I280 790129061034  /*BPS=13006  */
.I280 790129061035  CLOSE ALK ;  CLOSE M01;
```

```
;J209 790129061038  RHRUN: EXECUTION COMPLETE
;J200 790129061038  RHRUN: READY FOR REQUEST
;J209 790129061039  RHRUN: EXECUTION COMPLETE
;J200 790129061039  RHRUN: READY FOR REQUEST
;U000 790129061040  PIXSD: DATALANGUAGE OUTPUT PORT DIED  HOST='CCA-SIP'
** SOCK=
.I280 790129061040
;U000 790129061040  RHRUN: REQUEST PROCESSING INTERRUPTED
;I416 790129061040  RHRUN: DATALANGUAGE EOF (^Z FOUND)
;J160 790129061040  FCRUN: BYE
;0032 790129061040  ASPRIN: HOST='CCA-SIP' SOCK=8 USER='SDAC.SIP' REALMS
**=457360 CPUMS=90748 PGFLTS=878 PAGSEC=19593 LOADED=74 INCORE=433436 LK
**TOT=103 LKCNFN=2 DEVMT=3 BFSWP=603 COMMANDS=18 REQUESTS=4 FILEWR=4 PGR
**D=4 PGWR=312 TBMRL=1 TBMRD=22 PCHS=1232 PCSS=3868 SXPFR=2 PASDA=5120 P
**DSDA=3880 BGFILES=4 REOPENS=3 DIRF=5 DINS=20 DIRD=37 DIWR=129 DBWR=8 N
**AFN=7 DLMSGWR=37 DLMSGRD=27 DLBYWR=5933 DLBYRD=655 PORTRD=4 MSGRD=625
**BYTERD=155718 BITRD=4982976
.J900 790129061045  FCFINI: END OF SESSION
;0035 790129061045  ASFINI: HOST='CCA-SIP' SOCK=8 USER='SDAC.SIP' REALMS
**=465437 CPUMS=92185 PGFLTS=979 PAGSEC=19884 LOADED=7( INCORE=440269 LK
**TOT=112 LKCNFN=2 DEVMT=3 BFSWP=603 COMMANDS=18 REQUESTS=4 FILEWR=4 PGR
**D=4 PGWR=312 TBMRL=1 TBMRD=22 PCHS=1232 PCSS=3868 SXPFR=2 PASDA=5120 P
**DSDA=3880 BGFILES=4 REOPENS=3 DIRF=6 DINS=22 DIRD=44 DIWR=133 DBWR=8 N
**AFN=8 DLMSGWR=38 DLMSGRD=28 DLBYWR=6125 DLBYRD=672 PORTRD=4 MSGRD=625
**BYTERD=155718 BITRD=4982976
```